Learned Societies' Group for Scottish STEM Education

Advice paper

August 2022

Response to Scottish Government consultation on enhanced data collection for improvement

Summary

Formed in 2012, the Learned Societies' Group on Scottish STEM Education (LSG) brings together the learned societies and professional associations with a focus on the provision of STEM education at school.[1] We welcomed Scottish Government's intention to act on relevant recommendations from the Organisation for Economic Co-operation and Development (OECD)[2] and Audit Scotland[3] by ensuring the philosophy and mechanisms underpinning educational data collection in Scotland are fit-for-purpose. As a collection of learned societies, we ensure our policy positions are rooted in the available evidence, yet we are often constrained by what the available data can tell us. As one example, while the STEM Education and Training Strategy lists a Key Performance Indicator of meeting Initial Teacher Education student intake targets for all STEM subjects, there is little corresponding data on retention rates, making it difficult to know whether recruitment efforts have been successful over the longer-term. As long as gaps in the data exist, it will be difficult to gauge the true condition of the Scottish 'STEM pipeline' and what could most usefully be done to ensure every pupil can realise their STEM aspirations both in the classroom and beyond.

The unique breadth of our membership means we are well-placed to provide insights into how the STEM subjects could be impacted by changes to data gathering. We would be pleased to engage in further discussions with Scottish Government as the consultation progresses should they consider this helpful. We also look forward to engaging with the forthcoming 'national discussion on establishing a compelling and consensual vision for the future of Scottish education', as recommended by Professor Ken Muir and which this present consultation will inform.

Given our remit, the majority of our response will focus on how the proposals could impact the delivery and viability of the STEM subjects. However, the importance of robust and reliable data gathering transcends disciplines and impacts the functioning and success of the system at large. As such, we open with some general observations about educational data collection in Scotland, many of which we suspect will resonate with other subject-oriented societies and educational stakeholders.

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[1] This response has been signed off by: Association for Science Education; BCS, the Chartered Institute for IT; Edinburgh Mathematical Society; Institute of Physics; Institution of Engineering and Technology; Royal Society of Biology; Royal Society of Edinburgh; and the Scottish Mathematical Council. More information about the LSG is available at: https://rse.org.uk/about-us/governance/standing-committees/learned-societies-group/.

[2] OECD. (2021, 21 June). *Scotland's Curriculum for Excellence: Into the Future.* https://www.oecd.org/education/scotland-s-curriculum-for-excellence-bf624417-en.htm.

[3] Audit Scotland. (2021, March 23). *Improving outcomes for young people through school education.* https://www.audit-scotland.gov.uk/publications/improving-outcomes-for-young-people-through-school-education.

Summary (continued)

While there are valid reasons not to collect or share certain forms of data, it can undermine efforts to understand how the system is performing. For example, it was remarked that certain Key Performance Indicators (KPIs) found within the STEM Education and Training Strategy lack a corresponding publicly available dataset, making it difficult to determine the extent to which progress is being made.[4] Other KPIs are not disaggregated by subject, making it difficult to know whether trends are manifesting differently across them.[5] Streamlining public access to data would allow for it to be analysed in new ways by various bodies with an interest in educational outcomes, helping to fill gaps in our knowledge and devise the right solutions. It would also give stakeholders confidence in how such data is used to shape policy.

Subject to the appropriate anonymity controls, we are supportive of Scottish Government exploring more **longitudinal forms of data collection** (e.g. following pupils throughout the course of their educational careers across multiple institutions) to help track outcomes, evaluate interventions, and identify contributing success factors. From a STEM perspective, we know that engagement and interest in STEM tends to be naturally high in childhood before declining with time and so it is important **to understand what causes this drop-off from the 'STEM pipeline'** and to preserve progression pathways. Realistically, this can only be done if we possess the appropriate granular data (e.g. tracking individual subject choices and destinations over time) which can then be scaled up to inform accurate system-wide generalisations and recommendations. There may be lessons to be learned from the tertiary education sector in this regard, which tends to be more comfortable with anonymised data collection as a matter of course.

There is often **little to no integration between different datasets** which would otherwise help us to form a more holistic composite image of system performance and to identify important correlations that may be overlooked. The case of teacher recruitment versus retention referenced in our opening paragraph is one such example.

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[4] As two examples, there is no corresponding dataset underpinning the KPIs of 'Increase the cumulative hours of STEM professional learning accessed by early years, schools, college and CLD practitioners annually' and 'Increase the numbers of placements and internships with employers for college learners within STEM curricular areas.' Scottish Government. (2017, December 22). *STEM strategy: key performance indicators*. https://www.gov.scot/publications/stem-strategy-key-performance-indicators/.

[5] As an example, the KPI of 'Reduce the gap between the percentage of school leavers with 1 or more award in STEM subjects at SCQF level 6 or better from the least and most deprived SIMD quintiles to 31 percentage points by 2020 and to 25 percentage points by 2022' is not disaggregated by subject.

Q1: Our proposals for the key measures of progress towards closing the poverty related attainment gap are based on a number of key principles set out above. Are there any other principles that should be included?

As a reminder, these principles are as follows:

Our proposals for the key measures are based on a number of key principles:

- *we are looking at the difference in attainment between those children and young people from SIMD quintiles 1 and 5. However, we recognise the importance of increasing attainment for all children and are therefore proposing to recalibrate the national stretch aims for all five SIMD quintiles*
- *focusing on a single measure is neither helpful or meaningful and would provide a false and limited picture*
- *measures and milestones should be relatively simple to measure and report against*
- *there needs to be a clear line of sight from the agreed measures and milestones to the key priorities set out in the National Improvement Framework, including the need to place the human rights and needs of every child and young person at the centre of education*
- *there also needs to be a clear line of sight from the key measures in the NIF, to the strategies and approaches adopted in schools, and local authorities, to improve outcomes for children and young people*
- *the focus should be across the age ranges – from 3-18*
- *they should be a credible set of measures – understood to fairly reflect progress in closing the poverty related attainment gap*
- *the need to avoid perverse incentives through whatever milestones or stretch aims are set.*

1. The LSG does not have a position on the measures that are best suited to tracking the poverty related attainment gap, though we recognise the potential limitations of relying too heavily on the Scottish Index of Multiple Deprivation (SIMD) as the defining marker of poverty and deprivation as it is a geographically-based measure and thus not sensitive enough to pick up on individual variation. However, we agree that having reliable assessments of deprivation is critical as there tends to be a negative correlation between affluence and so-called **science capital,** which is defined as an individual's science-related knowledge, qualifications, attitudes, contacts, experiences, and resources. Science capital is most often fostered through regular exposure to science, such as through caregivers or regular visits to science centres and other forms of informal and formal engagement. Lower levels of science capital can preclude a young person's continued participation and interest in STEM. As such, it becomes critical to sustain the natural interest that many young children have in the STEM subjects by safeguarding their access to STEM pathways and opportunities throughout their learning journey. Unfortunately, restricted subject choice – if not in theory but in practice – remains a pervasive problem across the system, with research indicating that these impacts are most acutely felt in schools with more disadvantaged catchment areas.[6]

2. There has been research undertaken into the differential benefit of studying certain subjects and indeed **STEM subjects can be 'enabling subjects'** in terms of facilitating upward mobility.[7] However, according to data by the Social Mobility Commission from 2017, there is still a marked disparity in how people of different socioeconomic backgrounds are represented across various STEM professions, with only 15% of scientists, 9% of life science professionals, and 6% of doctors coming from disadvantaged backgrounds.[8] In fact, information from the British Cohort Study of 1970 (https://bcs70.info/) has concluded that the relationship between socioeconomic background and the likelihood of an individual pursuing a career in science is so strong that it can be described as a gradient, with those from a higher socioeconomic background being much more likely to work in science.

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[6] Dr Marina Shapira oral evidence to the Scottish Parliament's Education and Skills Committee, 19 September 2018 [online] Available at: http://www.parliament.scot/parliamentarybusiness/report.aspx?r=11680&mode=pdf.

[7] Britton, J., Drayton, E. & van der Erve, L. (2021, November 24). *Which university degrees are best for intergenerational mobility? Institute for Fiscal Studies*. https://www.suttontrust.com/wp-content/uploads/2021/11/What-Degrees-Are-Best-for-Social-Mobility.pdf.

[8] Friedman, S., Laurison, D. & Macmillan, L. (2017, January 26). *Social mobility, the class pay gap and intergenerational worklessness: new insights from the Labour Force Survey. Social Mobility Commission.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/596945/The_class_pay_gap_and_intergenerational_worklessness.pdf.

Data commissioned by the Royal Society confirms that those from lower socioeconomic groups continue to be underrepresented across the STEM workforce.[9] It would therefore be inherently beneficial to determine the extent to which pupils in more disadvantaged areas are able to access STEM subjects as an indirect determinant of whether the poverty related attainment gap is being reduced.

Q2: Should the two sub-measures covering attendance and exclusion at secondary schools be promoted to key measures?

There are currently four sub-measures covering attendance and exclusion in both primary and secondary schools, and there is a clear pattern of higher exclusion rates and lower attendance for children living in the most deprived areas. This is particularly the case at secondary school and prompts the question about whether to promote the two secondary school sub-measures. If children are not at school, then it is far more difficult to take the steps necessary to close the attainment gap.

3. It bears considering whether **attendance/ exclusion could potentially have disproportionately negative impacts on STEM attainment** given how it is often heavily predicated on practical laboratory work and that the STEM curriculum is often cumulative. This echoes concerns raised during the Covid-19 pandemic which saw pupils losing access to valuable opportunities for laboratory work that may have affected the depth of their learning.

Q3: Should data on confidence, resilience, and engagement from the new health and wellbeing census be included in the basket of measures?

In terms of health and wellbeing, three of the existing key measures already cover the social, emotional, and behavioural development of children and young people, and four of the fifteen sub-measures cover mental wellbeing. However, there will be data collected from the Health and Wellbeing Census which will be included as part of the indicator of educational attainment in the National Performance Framework.

These are:

- *Confidence of children and young people*
- *Resilience of children and young people*
- *Engagement in extra-curricular activities*

4. The LSG does not have a position on this question but acknowledges that holistic measures of attainment such as confidence and resilience are undoubtedly significant in determining a pupil's progress. However, **measures such as confidence are difficult to reliably conceptualise and assess**, particularly as stand-alone outcomes. Further, despite the importance of assessing these more qualitative attainment markers in some capacity (particularly as they correlate with more general pupil success), knowledge and skills markers remain more important when determining pupils' performance and development from a STEM perspective.

[9] Royal Society. (2014). *A picture of the UK scientific workforce: diversity data analysis for the Royal Society – summary report*. https://royalsociety.org/-/media/Royal_Society_Content/policy/projects/leading-way-diversity/picture-uk-scientific-workforce/070314-diversity-report.pdf.

Q4: At the moment, the measure of achievement in the senior phase is the National Qualifications achieved by young people at the point which they leave school (SCQF levels 4, 5, and 6 – 1 or more on leaving school). Do we need to add other measures to cover wider achievement and attainment?

Q5: If you answered yes, some options for consideration are set out below. However, we would also welcome any other suggestions for additional measures:

Option 1

In response to feedback from users, and to improve the evidence base on the attainment of broader achievements and skills as part of the Curriculum for Excellence, a new 'all SQA qualifications' measure has been developed which includes National Qualifications (National Courses, Skills for Work) and other SQA qualifications (Customised Awards, Higher National, National – Workplace, National Certificates, National Progression Awards, Professional Development Awards, Scottish Vocational Qualifications, Ungraded National Courses). Details can be found in section 6.3 of the School Leaver Attainment and Initial Destinations publication. The 'all SQA qualification' measure details the proportion of school leavers who attained a number of passes (e.g. one pass or more, two passes or more etc.) at a given SCQF level or better across all of the qualifications outlined above. One or more combination(s) of passes and SCQF levels could potentially be used.

These statistics are currently labelled as Experimental Statistics, reflecting that they are undergoing development and subject to revision based on informed feedback from users.

Option 2

A measure of attainment in vocational qualifications. Section 6.1 of the School Leaver Attainment and Initial Destinations publication contains a measure covering only 'vocational' qualifications. Unlike the existing NIF key measures on school leaver attainment and the 'all SQA qualifications' measure outlined above, this measure does not include attainment in National Qualifications but focuses on vocational qualifications. Specifically, the measure includes National Certificates, Higher National Qualifications, Scottish Vocational Qualifications, National Progression Awards and Skills for Work. It shows the proportion of school leavers with one pass or more at a given SCQF level. The proportion of school leavers with one pass or more at SCQF level 5 or better is used as a Key Performance Indicator for Developing Scotland's Young Workforce.

5. The LSG commented on the changing nature of qualifications in the context of its response to the OECD review of Curriculum for Excellence (CfE).[10] The CfE review was an important first step at determining what a fit-for-purpose approach to assessment in Scottish schools should look like, including in the wake of Covid-19 and the agility it has demanded of the system. Scotland should continue to consider the purpose of qualifications at various levels and whether these are being realised in practice, in order to ensure that curriculum, assessments, and qualifications form an integrated whole. The question remains of how we achieve greater diversity in approaches in Senior 4-Senior 6 and parity of esteem for different pathways, so that the totality of achievement in S4-S6 becomes the focus. The LSG looks forward to engaging with the impending review of qualifications and assessments being led by Professor Louise Hayward, which will give us an opportunity to develop our policy position on this matter in more detail. In principle, the LSG is **emphatically supportive that a plurality of achievement and attainment markers be equally recognised and valued**, reflecting the diverse ways in which pupils can demonstrate their understanding of, and passion for, the STEM subjects.

[10] Learned Societies' Group on Scottish STEM Education. (2020.)
Learned Societies' Group response to the OECD review of Curriculum for Excellence.
https://rse.org.uk/about-us/governance/standing-committees/learned-societies-group/.

Q6: In terms of measuring progress beyond school, should the percentage of school leavers going to a 'positive destination' on leaving school be included alongside the participation measure?

Positive destinations for young people leaving school include Higher Education, Further Education, Employment, Training, Voluntary Work and Personal Skills Development (while other destinations include unemployed and seeking work, unemployed and not seeking work and unknown). These provide valuable information on the activities being undertaken by school leavers. However, they are based on a snapshot of the activity being undertaken by school leavers on a given day and are not the best indicator of long term sustained success for young people accessing future work or study.

That is why the indicator we have used previously is the Skills Development Scotland Annual Participation Measure, which reports on the wider activity of the 16-19 cohort, including those still at school. This is an indicator of school success in preparing young people for access to future work or study.

6. The idea of a **'positive destination' is important but subjective** and therefore difficult to define, particularly over the longer-term. This again underscores the value of more longitudinal data-gathering.

7. Young people can sometimes have misconceptions about the careers that are available to them after studying STEM subjects, or indeed about STEM careers themselves. Pupils may believe that a STEM education limits their choices or that a STEM career lies outside their reach as they presume it requires specialised or advanced qualifications. While we should continue to promote more 'traditional' STEM pathways (e.g. medicine), we would also support more contemporary **careers advice for pupils that is informed by a solid understanding of the current and future labour market and which promotes a multitude of progression options.** For example, a report[11] by the Institute of Physics found that half of the available roles in Physics do not require a degree in Physics, which would likely be surprising to many pupils.

Q7: What more do we need to do in order to ensure that a wider range of measures are in use across the education system, and that they are valued as equally as traditional attainment measures?

Q8: Are the existing wider data collections, and the new data developments enough to ensure that the National Improvement Framework reflects the ambitions of Curriculum for Excellence, national policy priorities such as health and wellbeing and confidence, and key priorities for Covid-19 recovery and improvement, as recommended by Audit Scotland?

8. One of the defining characteristics about Curriculum for Excellence (CfE) is its flexibility; in theory, pupils can pick up subjects down the line even if they do not take them at the (traditionally) prescribed time. In practice, **picking up more intensive or cumulative subjects such as the STEM subjects later in their schooling** (without the gradual preparation they would otherwise have) can potentially lead to poor academic outcomes for pupils and they may be more likely to drop these subjects.

9. It might therefore be **beneficial to have more comprehensive data on how many pupils pick up STEM subjects later on and how they fare** so we can tackle attrition at critical stages like S4 and reveal if STEM subjects are disproportionately impacted by this discontinuity.

10. This ties into more fundamental considerations around the health of the **STEM 'pipeline'** and the benefit of knowing the precise point at which students disengage from STEM so that continuity can be improved.

[11] Institute of Physics. (2021). *Unlocking the potential of physics skills in the UK and Ireland*. https://www.iop.org/sites/default/files/2022-01/IOP-unlocking-the-potential-of-physics-skills.pdf.

Q9: How can we make better use of data to focus and drive improvement activity at school, local, regional and national level?

11. Fundamental to any discussion of data is the idea of **data literacy.** We should ensure that data is not misrepresented or misunderstood by decision-makers, the media, or the public (for example, falling short of targets does not negate signs of improvement where they exist and so we should be conscious of the story that the data is telling us rather than just focusing on absolute numbers).

12. STEM attainment is not always adequately captured by prevailing measures of knowledge and skills attainment, which tend to focus on literacy and numeracy. While we do not necessarily advocate for the introduction of STEM-specific attainment markers, mindful of the bureaucratic burdens this could impose on teachers, we would welcome a consideration of how STEM attainment might be better reflected across existing data metrics.

Q10: How can we make better use of data to help reduce variation in outcomes achieved by young people in different parts of the country?

13. As mentioned in response to question 6, there is a role for data in dispelling misconceptions about STEM careers and pathways in an effort to encourage greater participation as well as evidencing the wider benefits and contributions of the STEM subjects to society.[12] For example, improving gender representation in traditionally male-dominated and higher-earning STEM roles could have positive indirect effects on reducing the gender pay gap.

14. Scotland also needs accurate and accessible data on skills shortages to further underscore the importance of investing in the STEM pipeline, particularly in the context of achieving a just transition. A decarbonised society will require new types of jobs, many of which are likely to lie in STEM fields; it is crucial we understand what these jobs will be and market them accordingly to interested pupils. This reemphasises the importance of having integrated data so that the **wider, societal implications** of meeting (or not meeting) educational objectives are properly understood.

Additional information

15. Any enquiries about this advice paper should be addressed to Daria Tuhtar, Policy Advice Manager, at dtuhtar@theRSE.org.uk.

[12] Walker, I. & Zhu, Y. (2013, October 10). *The benefit of STEM skills to individuals, society and the economy: report to Royal Society's Vision for Science and Mathematics*. https://royalsociety.org/~/media/education/policy/vision/reports/ev-9-vision-research-report-20140624.pdf.

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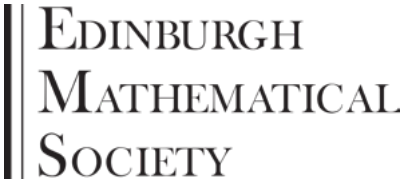

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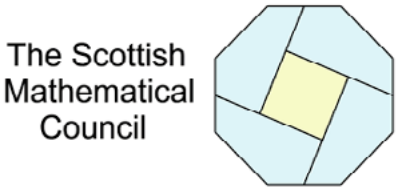

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